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Prediction the Return Fluctuations with Artificial Neural Networks' Approach

Masoud Taherinia*, Mohsen Rashidi Baghi

Department of Accounting, Lorestan University, Economic and Administration Science Faculty, Lorestan, Iran.

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ABSTRACT

Time changes of return, inefficiency studies performed and presence of effective factors on share return rate are caused development modern and intelligent methods in estimation and evaluation of share return in stock companies. Aim of this research is prediction of return using financial variables with artificial neural network approach. Therefore, the statistical population of this study includes 120 listed companies in Tehran stock securities during 2007 to 2017. Independent variables in this research are market variables (Earning quality, free cash flow) and dependent variable is share return. The obtained outputs from estimation of the artificial neural networks and results obtained from estimation, using of this method with evaluation scales concerning random amount and comparing it with adjusted R, we found that there is meaningful relation between the associated variables and return. However, such network has the least error than other networks.

1 Introduction

Consuming than simple regression models, predictor maybe use only of nervous neural models that this difficulty and complexities are useful and applicable [2,4]. One of the reasons of employing the neural Networks is its nonlinear aspect in prediction [15]. Nonlinear aspect maybe as complex relations between dependent or Independent variables in up or down thresholds for affecting on independent variables, or may be the difference between up and down limit of predictions related to dependent variable [4]. Brooks [3] and Qi [13] stated that the continuous changes in nature of financial relation is a factor for change of traditional approach to artificial neural Networks approach and abandon traditional techniques. This operation performs, using of one reversible approach, in that, researchers eliminate the traditional observation with accessibility to new observation simultaneously with production new time series for prediction.

Prediction means variables perception that used to explanation variable reactions, this means the clear perception need of timing relations between many variables and perception statistic value of these relations, and also, the training which variables are more appropriated with respect to their signals to predicting marker changes. The better prediction in regarding to increasing financial market

*** Corresponding author Tel.:** *+989167433461*
E-mail address: *taherinia.m@lu.ac.ir*

disturbance throughout investing flows is the key element to better financial decision precise prediction methods to portfolio management has high significance by investors and creditors. Financial experts can simply state action of obvious assets on market value in the form model. But, in relation to unobvious actions haven't this capability. Time series models stated by financial theories are the base to predicting data in recent century. One of the most desirable procedures to converting market value to as model make use of intelligent systems, including artificial neural networks that, not included standard formula, and simply maybe insert market changes in there. The aim of this study was to test the relationship between earnings quality, free cash flow and share return, to identify variables that are most relevant and how the power of describing variables identified through the analysis of the variables measures of liquidity and profitability, increases. Profit and free cash flow variables, were considered for each share. One of the most favorite solutions for transforming the market value into the form of a model is using the intelligent systems including the artificial neural networks which do not involve the standard formulas and the market changes can be easily applied. According to the created value analysis for the shareholders the firm's return is so important. There are different viewpoints on applying and using the resources.

On the one hand, managers can invest the mentioned resources in projects with current positive net value through increasing the dividends or using the appropriate growth opportunities and in this way they increase their shareholders' wealth [2]. The results of studies show that with decreasing the authorities' costs resulted from the higher earning quality can cause the market's positive reaction to the return fluctuations and finally increase the firm's value [17]. Since optimized resources' using can be effective on the investors' tendency to invest more and getting the creditors' trust to give credits. Concerning the simulated business activities Thawornwong and Enke [14] found that if different business strategies are applied by investors, the obtained results from earnings may change. In fact, it is possible that with more investigations about the received earnings the investors will be more benefited. These differences are resulted from applying different business strategies. Also, they suggested that business simulation in future studies under the stock earning scenarios, transaction costs, and return fluctuations should be considered for real investing approaches' repeatability.

2 Theoretical Frameworks

Fama [5] expressed that share return and or prediction of share market is one of the important financial issues. That, is regarded by researchers from past to the present. It's based on the hypotheses that past information are the public availability to predicting future share return by using of them. Samples of these information consist of economic variables such as, interest rates, foreign exchange rates. Industry specific information as industrial productions growth rates. Consumer price, company certain information as profit and loss statement return and divided profit. However, attempt for predicting share return, is unlike the public perception of market efficiency.

Efficient market hypothesis explain that all available information is reflected in efficient market before individuals can trade on it (obtain abnormal return). Consequently, prediction of share price is impossible to predicting share return, since markets fully reflect all available identified information in relation to share. Immediately efficient market regulates randomly the share price, on the basis of news is reaching. Therefore, there are many discussions, based on inefficiency market, and with rely on this reasoning may be used of share price to predicting share return in future. During several past

years, considerably evidences are obtained to market total inefficiency proof. Actually, many researchers present the evidences that the share market return is predictable, using of public information available, including: time series data, financial and economic variables, specifically. Variables with one important component of commercial cycle [1, 19]. Many changes and events occurred in share market cannot stated directly as a model, that, this states the type of limitation in using of regression models. In recent years, exploration of nonlinear relations in financial market is focused by various researcher and financial analyzers. Nonlinear statistical methods available that used to fulfil better predictions of share return and or future price, but many techniques and approaches are axial model that his necessary these nonlinear models are being regulated before estimating the determinate parameters. In contrast, neural networks are axial data approaches, they have no require to regulation in model processing period. Since, they encompass independently inherent relations between variables. So, neural networks have the ability to perform for nonlinear models without primary knowledge than relations of output and input variables [8, 16].

Thawornwong and Enke [14] with respect to the simulated commercial operations found that if various commercial strategies also used by investor may be change obtained results of profitability. Actually there is a possible that investors profited from by more researches in relation to receivable profits. In the future, which these difference caused by applying various commercial strategies. Also, future researches must be considered commerce simulation under share profit, transaction cost, and tax scenarios to repeating of actual investment methods. Gooijer and Hyndman [7] studied advantages and limitations of various prediction methods and resulted that the presence many potential problems of another method appear in comparison time with artificial neural networkS. Preminger and Franck [12] made use of regression models and artificial neural network for predicting foreign currency rate and resulted that the current models were better than the traditional models, but using of random step method yet has preference than other methods. Preminger and Franck [12] with use of artificial neural networks forecasted the exchange rate and concluded that the current model is better than conventional models, but still random walk method over other methods is an advantage [11].

Nasr et al. [11] with studies conducted on artificial intelligence systems concluded that artificial neural systems provide a tool for auditors to increase their ability to rely on collected evidence. Kumar and Ravi [9], 128 articles studied in relation with prediction of bankruptcy of bank and companies, and resulted that artificial neural network method was better than many methods combined systems can have been better performance by combination advantages and differences of these methods. Kuo et al [10] in an article as backup intelligent system of share transactions decision by applying and gathering genetic algorithms on the basis of phase neural networks, artificial neural networks has established the consultant system for keeping, sell or purchase share in stock market, the feature of established system, is providing possibility quantify of qualitative variables involved in predicting of share price. This researcher in 1997 is performed article with similar title, without considering genetic algorithms. In such article questionnaire with Dolphy phase method has been used to use of view of experts in predicting of share price. Gencay and Stengos [6], the use of two simple trading principles namely moving averages and transactions spectrum fracture combined using of one feed forward neural network to predicting daily return average index Dava-Jonez (DJLA) Purchase and selling signals produced by transaction principles used as prediction model data.

Hypotesis: we can predict the Return Fluctuations with Artificial Neural Networks.

3 Proposed Methodology

Statistic society studied in this research consists of all listed companies in Tehran stock Exchange in 2007 to 2017. Actually, the reason of selection is homogeneity of information such companies, observation certain laws and regulation and passed standards and availability information, and financial statements of these companies on this basis 120 companies are considered as statistic society. Considering the characteristics of neural networks, the number of tested data is more, the better answer of network is caused. All companies that were selected of research statistic society, is selected and tested as statistic sample and so the research sample was the same statistic society, and sampling didn't perform to select sample in level of every company. Tehran stock companies to locating in statistic society must have below:

- End of financial period of companies was 20 March and no one didn't change financial year during research period.
- Companies have been in the exchange activity constantly in the period 2007 to 2017.
- Complete formation related to companies is available.

3.1 Artificial Neural Networks

In this type of plans, exist the conception as learning that this learning is obtained on identification and gathering relations between one output and input set. In simple talk learning in these plans is obtained by expanding set of memory inside inputs with set of outputs with knowledge of the set of examples results. Artificial neural networks are shown good performance as a modern method in modeling and forecasting nonlinear and nonpermanent time series of process which there is no clear solution and relation to their exact identification and description. Total ability of artificial neural networks is the application nonlinear relation between data and results generalization for another data. Artificial neural network models with the instruction that has seen maybe forecasting the system behavior without clear mathematical relation. Two types of very applicable neural networks in financial department are multilayer perceptron and Generalized feed forward. (a) MLP neural network that perception network is defined the set of interconnected neurons that produce the result by receiving one input series of neurons and fulfill certain operation and if the result was more than the given threshold, yields one amount as output. In this type of networks, input of the first layer of the neurons is connected to the next layer, and this subject was true in every level until reach to the output layer.

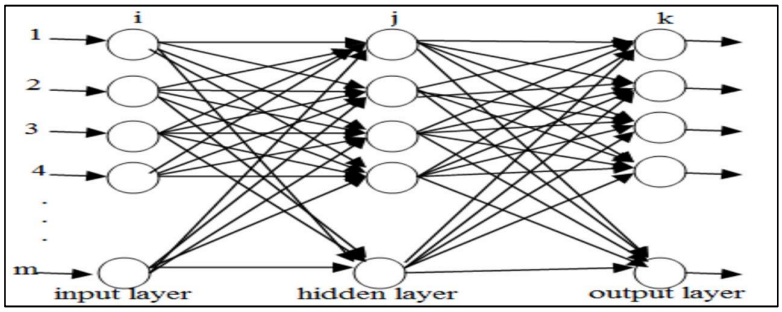

Fig.1: Multilayer perceptron network

The most common type of networks in forecasting and solving nonlinear problems are networks, known as multilayer perceptron education these networks perform, using of error back propagation algorithm inputs of these networks are as a vector x (x_1, x_2. …x_n) and every input of connected to the related node by one weight and finally sequence of weights is connected to the considered node, as weight vector w (w_1, w_2, …, w_n). **W** shows the relative weight of former layer node to the above mentioned layer. Node output that is called **y**, calculated in according to the follow relation.

$$Y = f(x, w - b) \quad (1)$$

Which in this relation, X is input date vector, W is weight vector, B is threshold amount or bios. Inside of node, processor is accounted the transfer function of output producers of that node. (b) GFF neural network that this type of network issued in Generalized feed forward neural network. Generalized feed forward means that artificial neuron is located in sequence layers and forward output (signal) itself. Back propagation term also means that the errors is fed in the back of network, to correct the weights there after, again repeat itself forward route input to output.

3.2 Artificial Neural Network Method

during the last two decades, we have been witnessed the presence successfully artificial neural networks in management and finance issues and many articles have been presented and training idea for solving problems of identification of complex patterns, using of approach intelligent data factors for university researchers has been very challenging. Neural networks are very valuable tool for wide range of the financial and management fields that are caused, as a vital component of most data collection systems, the change of the approach of people and organizations to the relation among data. To build a neural network model and the use of it we must follow the steps below:

(1) In this step – the number of layers and network nodes and network type and basis and stimulated functions are selected. So appropriate software for network is selected and prepared.

(2) Aim of the work learning is values correction of network weights for multiple samples with respect to type of learning algorithm. Information related to the considered patterns are shown as educational data for several times to the network and network correct the value of their weights during the learning process for each group of educational pattern After repeating this action for high frequency, weights such a way that used that with view information of each pattern can retrieve it. With change of the transfer functions, the number of layers and nodes of per layer and the effective factors on the weights learning as error and try is achieved the desired output.

(3) After the training phase was completed, to ensure of optimum performance of network, it's tested for a bunch of known information, and removed possible defects, after completing this phase, the network will be ready to use. In network design, In addition above steps and then determination the type of network and the learning method – determination the following variables are important. The number of input nodes, the number of hidden layers and hidden nodes, the number of output nodes selection the number of inputs in neural network has special importance, since each input pattern includes the important information about its structure of complex correlated data, most researchers to obtain the number of input pattern have used of try and error method. In this research, the number of input pattern is selected with respect to the sample size and with try and error method. In issues relat-

ed to the prediction that the prediction horizon usually is one step forward and with respect to that the number of output nodes is depends on the prediction horizon, the output node is one node. Hidden layers and nodes also play an important role in neural networks. Hidden layers in hidden nodes allow to neural network, to detect and identify data characteristics and there by establish the complex non-linear records between input or output variables. In theory, the neural networks can gain desired accuracy for functions approximation using a sufficient number of hidden node in hidden layer. In this research, have been selected the number of hidden layer with try and error method and the results. Different models in determining the appropriate topology of neural networks tested and by changing of the number of layers and neurons in hidden layers, selected the basic model of prediction. After performing various tests in this study, the number of desired layers in this study are three layers (one input layer one hidden layer and one output layer) with four number of neurons.

3.3 Variables Definitions

Dependent variable is defined as Stock return. In this research, the stock return of the whole revenues obtained from the investment in a certain period towards the certain period of investment during that period has been considered [2, 20]. Generally, the stock return can be calculated as following:

$$R_t = \frac{(P_{t+1} - P_t) + DPS_t}{P_t} \tag{2}$$

In above formula:

Rt = Normal share return in the period t

Pt+1 = Company share price in the beginning of period t+1

Pt = Company share price in the beginning of period t

Dpst = Cash profit belonged to company share in the period t

If company proceed to increasing capital from cash earnings and receivables or reserve p_t and pt+1 are not comparable, dated difference in the number of share before and after capital appreciation so pt+1 must be regulated.

Independent variables are described as following:

Free cash flow: Free cash flow is calculated through the following formula [17]:

$$FCF_{it} = INC_{it} - TAX_{it} - INTEP_{it} - PSDIV_{it} - CSDIV_{it} \tag{3}$$

INC_{it}: the operating earnings before the depreciation of firm i in the year t, TAX_{it} the whole paid taxes of the i firm in the year t, $INTEP_{it}$ the cost of paid interest of the firm i in the year t, $CSDIV_{it}$ shareholders' paid stock earnings of the firm i in the year t.

Earning quality: in this study the proportion of operating cash flow to the operating earning has been used for calculating the earning quality [17, 18].

Free cash flow in firms with higher earning quality: in order to determine the effect of earning quality on the relationship between the free cash flow and return an imaginary variable has been used. First of all, the mode of the earning quality is obtained, then for the observations which are more than the sample mode the number of 1 and for other observations the number of 0 is set. With multiplying the imaginary variable coefficient by the free cash flow, the free cash flow for the firms with high

earnings quality is obtained [17].

4 Research Data and Statistical Sample

In first step to compiling research theoretical fundamental is used of library method and in the second step, to collecting Intended data is used of financial statements and information presented to portfolio organization. In this research after collecting the needed data, in Excel software medium, is performed data homogeneity test normality test. After selecting the mentioned period data needed to analyses information with artificial neural network methods provided in Neuro Solution software. In next step by applying very try and error is selected the most appropriate type of neural Network that has the best scales for evaluation. By performing above work, in two simulation and estimation models, the number of hidden layer, the number of effective neuron in each of layers, the number of repeating …, how are determined that obtained the best results in the both of estimation and simulation process. It is mentionable that this research goal function is regarded to reduce to tall error squares mean to evaluation accuracy of compiled model of the artificial neural network, is used of statistic scales as coefficient of determination (R^2), error squares mean (MSE) absolute error mean.

For predicting return using research variables with feed forward neural network approach that is generally called multilayer perceptron networks (MLP) is used, for training the above neural network make use of error back propagation learning rule. This law is composed of two main routes. The first path is called went path, that in this route is applied to the multi-layer perceptron network and effects is transferred through intermediate layer to the output layers. The output vector formed in the output layer, form the real answer. In this route the network parameters is considered fixed and unchanged. The second path is called the back path. In this route, unlike the went path, the network parameters of multi layers perceptron network change and set. This adjustment is done in accordance with the law of error correction. Error signal forms in the output layer of network. The error vector is equal with the difference between the de sired answer and real answer of network. After calculation, error value is distributed in the back path of the output layer, and through network layers in the entire network. Because, the recent distribution, is done in contrast synapse weight communication route the word the back error propagation is selected to describe network behavior correction of network. The network parameters are such adjusted, so that the real answer of network will be closer to the optimal answer.

Learning algorithm used in this research. Is the algorithm of the back error propagation and the faster learning is used algorithm of a reactionary back error propagation? The number of replication in this study is 1000, that Tables of prediction value and real values and other Tables obtained from neural networks are shown in below figures. As previously mentioned, some common performance measures are used to demonstrate how learning of data communication in neural networks. In prediction issues, these measures mainly are related to the error between the predicted outputs and real desired output. The common performance measures for prediction problems (linear and on linear) previously mentioned the first three cases are the families of standard error mean calculation standard mean error squared (MSE) error mean squared (RMSE). R^2 is the coefficient of determination, that R^2 Shows the direction of Independent or dependent variable and its values between zero and one and the one value shows the full compliance of data while zero value for R^2 indicates the performance that can be expected using of real output value mean (d) as the basis of predictions. Another measure to evaluate performance of neural network is mean of absolute error (MAE).

5 Results and Estimates

The methods of artificial neural networks with use of sensitivity analysis will determine the correlation of the input variables (independent) and output (dependent). Therefore, the network will design based on optimal plan and data input and output and these relationships will be tested, the following figure shows this relationship.

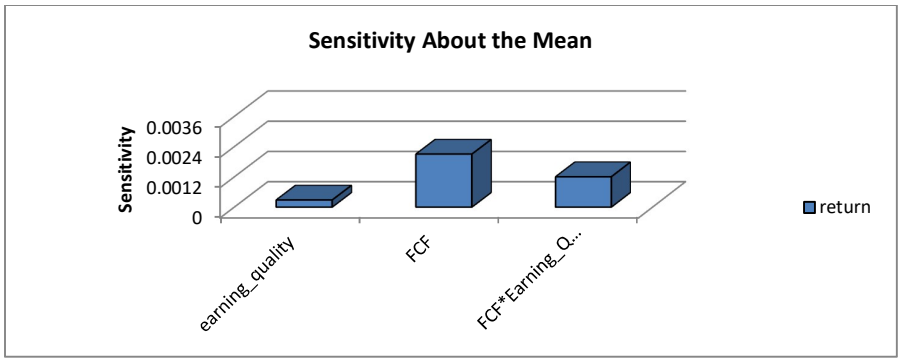

Fig. 2: Linear sensitivity between stock return and independent variables using ANN

The results of Table 1 show that the relationship between stock return and free cash flow in firms with higher earning quality is significantly stronger than this relationship in other firms. At this stage to choose the transfer function type and the appropriate training rule two types of multilayer Perceptron and Generalized feed forward networks with changing the transfer function and the type of the training rule were made and run. It is worth mentioning that compiling the models which the momentum rule has been used in their training the amount of the momentum has been regulated in form of trial and error in a way that the run models have the greatest accuracy. Also, to find the best number of hidden layers and their neuron number the applied network with one through three hidden layers were made and run which the obtained results showed that the made networks with one hidden layer and four neurons are more appropriate. Another result of Table 1 is the superiority of multilayer neural network of Perceptron over the type of generalized feed forward.

Table 1: Changing coefficient between dependent variable & other variables

Sensitivity	Return
Earning Quality	0.0001
FCF	0.0015
FCFEarning_Quality	0.0019

Then the best multilayer Perceptron structures have been chosen and other relevant structures for obtaining the best base were tested. These tests are conjugate gradient and Levenberg-Marqant which is independently calculated for both Perceptron and Generalized feed forward structures. The obtained results from this part are presented in Table 2. Investigating the mentioned table and comparisons made it clear that the best structure for multilayer perceptron is the tangent momentum which also is

about the generalized feed forward, too.

Table 2: Artificial neural network features

	Transfer	Learning Rule	MSE	MAE	R
MLP	TanhAxon	Momentum	0.4659	0.3548	0.003
	TanhAxon	Conjugate Gradiant	0.3547	0.4651	-0.011
	TanhAxon	LevenbergMarqant	0.3461	0.4570	0.1058
	SigmoidAxon	Momentum	0.3632	0.4774	-0.0058
	SigmoidAxon	Conjugate Gradiant	0.3633	0.4776	0.0053
	SigmoidAxon	LevenbergMarqant	0.3535	0.4659	0.0528
GFF	TanhAxon	Momentum	0.3842	0.4984	-0.0193
	TanhAxon	Conjugate Gradiant	0.3623	0.4751	-0.0075
	TanhAxon	LevenbergMarqant	0.3533	0.4650	-0.0370
	SigmoidAxon	Momentum	0.356	0.4650	-0.0115
	SigmoidAxon	Conjugate Gradiant	0.3606	0.4738	-0.0069
	SigmoidAxon	LevenbergMarqant	0.3724	0.4904	0.0561

In Figure 3, the return is calculated regarding the input, output data, and the chosen structure by artificial neural networks.

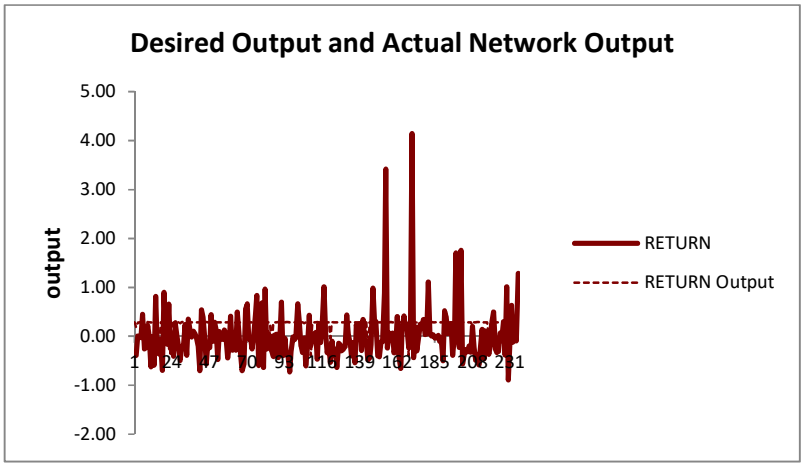

Fig. 3: Simulated return test using ANN

Regarding the Table 3, between the multilayer perceptron and generalized feed forward structures the best structure was introduced and with respect to Figure 3 Levenberg- Marqant network with tangent transfer function was selected.

Table 3: Chosen ANN features

Network type	Hidden layers number	Transfer function	Train			Train rule	Test		
			MSE	MAE	R		MSE	MAE	R
GFF	1	TanhAxon	0.342	0.441	0.110	Levenberg Marqant	0.346	0.457	0.105

In this part the correlation between the real and training input variables with return has been determined. The results indicated the significant relationship between the free cash flow variables for the firms with higher earning quality.

6 Conclusions

As it was mentioned, this study used the Artificial Neural Network as a factor to estimate and predict the stock return. Neural networks investigate the non-linear relationships between variables (modeling the human neural network). The results indicate the existence of significant relationship (R=0.10) between the free cash flow variable and stock return. Also, the introduced neural networks can be used in analyzing the sensitivity of comparing the effect of independent variables including the firms' free cash flow with higher earning quality and free cash flow of other firms which regarding the executed sensitivity analysis this fact was indicated. The relationship between the stock return and free cash flow of the firms with higher earning quality is significantly stronger than this relationship in other firms. One of the reasons of applying neural networks is optimizing the selected parameters for prediction, because finding these parameters in normal situation is very time-consuming. The results of this study showed the relative success of the neural networks' models in expressing the relationship between the stock return and different free cash flows. The executed sensitivity analysis on different functions and also the optimized modeling results make it clear that using the all base information as the input index for modelling will have the best results. It is suggested that the future studies apply this method more and more. The results of this research show relative successful in neural networks models in describing relation among research variables and return. By regarding the results obtained of modelling also maybe said the use of neural network isn't lead to improvement of results obtained of perceptron network, but, using of Genetic algorithm in a neural network structure may be lead to the better results. Relation between return and research variables in different industry level aren't same and stable. and this correlation under go to change by different reasons performed sensitivity analysis over various function and also modelling optimal results denote that the use of all basis information will not be follow on the best results as input index to modelling. It is suggested this method further will be review in future research. In direction of obtained results, may be presented the following recommendations. By regarding the meaningful nonlinear relation among research variables (operation cash flow and earning quality) and return, it is suggested investors focus on the other related factors, too. In the other words to aware of appropriate distinction must be regarded other tools related to return such as decision of board of directors, organizational structure studied industry, profit distribution uniformity.

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